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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosol optical depth measurements by airborne sun photometer in SOLVE II: Comparisons to SAGE III, POAM III and airborne spectrometer measurements" *by* P. Russell et al.

P. Russell et al.

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General author comment: We thank the anonymous referees for their efforts in reading the ms and offering comments that have helped us improve it. Our specific responses follow each referee comment below.

Anonymous Referee #1

Referee's General Comments

This paper discusses at length and in great detail, aerosol optical depth measurements

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made by the NASA Ames sun photometer mounted aboard a DC-8 during the SOLVE II campaign. In particular it compares these multi-wavelength measurements with those of the DIAS instrument and the SAGE III and POAM III satellites. Most of the paper is devoted to a detailed consideration of the differences in the sets of results and an examination of possible causes for the discrepancies - in particular between the sun photometer (AATS) and SAGE III. Although it seems that some of the observed differences might be explained by differences in viewing path, in timing and in solar zenith angle, for the most part these cannot explain all the differences observed. The authors then examine other possible causes one by one.

The paper is well-written, clear and very thorough. I have no doubt as to its accuracy and the scientific methodology employed, and the paper is fundamentally very sound. It presents new data and new results, which are scientifically interesting.

Response: We appreciate the positive comments.

Referee: Its major weakness stems from the nature of its conclusion that significant differences exist between the SAGE III and AATS measurements which are unresolved. This may indeed be the case, but in order to make a useful contribution to this problem, the authors need to at least state what they intend to investigate next as the cause, or what further experiment or data would be needed in order to resolve the problem. Although there is a valid and significant scientific contribution made by stating that a problem exists and that they have examined umpteen different possible causes, which have not led to a resolution - this is not enough. The authors need to state either where they intend to look next for an explanation, what further data or calculations are necessary, or what further experiments must be carried out.

Response: We agree that a valid and significant scientific contribution has been made by stating that a problem exists and that we have examined many different possible causes, which have not led to a resolution. To address the statement that this is not enough, we have added a short discussion of possible future work that would help to

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resolve the discrepancies. Specifically, just before Appendix A we have inserted:

"The analysis presented here clearly reveals that more work must be done to understand even the satellite comparisons themselves. This will require quantitative comparisons of both aerosol extinction and transmission profiles from the SAGE III, SAGE II, and POAM III instruments, and is the subject of future work. The POAM-SAGE differences shown in Figures 21 and 22, including their seasonal evolution, provide important context for the AATS-POAM and AATS-SAGE comparisons, as well as potentially important clues and a data set that can be studied in search of a resolution of the AATS-SAGE differences."

Referee: My other general comment for resolution is the size of the figures. I cannot read them even with a magnifying lens. All the figures need to be printed at least twice as big as their current size in the pdf manuscript.

Response: We also were concerned by the small size of the figures in the ACPD version - much smaller than the versions we submitted. We raised this concern with the EGU Production Office, which said that figure size can be enlarged when the paper is converted to two-column style for the final ACP version. The Production Office thought the small figure size in the ACPD one-column style was big enough since readers can use the zoom tool of the Acrobat Reader to enlarge the figures. We feel this is not an adequate solution for ACPD readers who print pages in ACPD size (two ACPD pages per printed sheet). The referee's difficulty reading the figures bears out our concern. We will work with the Production Office to be sure figures are fully legible in the final ACP version.

Referee's Specific Comments

There is an enormous amount of detail in the paper, including 4 pages of Tables and 24 figures. I am not sure that quite as much detail needs to be presented. The fact that the figures are far too small made it impossible for me to examine them in much detail. I would suggest making the paper more readable by eliminating some of the figures -

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although I do not have specific recommendations. Many of the discussion points can be made without reference to a figure, and it would certainly help to reduce the length of the paper were this done.

Response: Referee #2 has made some specific recommendations on which figures to drop, and we have done some of this, along with some other deletions. See our response to Referee #2 below.

Referee: I also think that the Appendix is unnecessary.

Response: Here we disagree - we feel the Appendix is necessary to demonstrate clearly that the window was frost-free during the measurements reported here. In fact, Referee #2 has pointed to the need to assure that the measurements were not affected by deposits on other parts of the instrument optical path. Providing this assurance is similar to what we have provided regarding window frost. We now provide this in a slightly expanded Appendix, with brief mention in the main text.

Referee: One other comment - is "airmass" a common term? I found its use quite confusing because I would not normally consider the ratio of the slant path optical depth to the vertical optical depth to be an "airmass" but more of an optical path difference (or ratio).

Response: "Air mass" or "airmass" is the terminology used by Thomason et al. (1983), Reagan et al. (1986) and most of the rest of the atmospheric Sun photometry community to describe the ratio of line-of-sight (LOS) optical thickness (OT) to vertical OT. The referee is certainly correct that it is a ratio. That is why Kasten (1966) calls it "relative optical airmass" and why we have introduced the terminology as "relative optical airmass (here called airmass for brevity)" on p. 7294, line 4, carefully defining it as "the ratio of LOS optical thickness (OT) to vertical OT".

Kondratyev (1969, p. 162) calls the same quantity "atmospheric mass" but hastens to add "It should be emphasized in this connection that the concept of atmospheric mass

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has nothing in common with the general idea of mass. Atmospheric mass in the given case is a dimensionless quantity indicating by how many times the optical thickness in the direction of inclination exceeds the optical thickness in the direction of the vertical."

Hence we certainly empathize with the referee for questioning the use of the term "airmass" for an optical thickness ratio. It's not very intuitive terminology. But it is quite standard, and we don't think we should attempt to change it at this point. We think our introducing it as we have on p. 7294 is the best way to go.

Technical Corrections

Referee: pg 7297, line 21. Figsures should be replaced by Figures.

Response: Correction made.

Referee: pg 7298, line 20. "more-transmission oriented" should be replaced by "more transmission-oriented"

Response: Change made.

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